The Journal

OF THE AMERICAN SOCIETY OF SAFETY ENGINEERS

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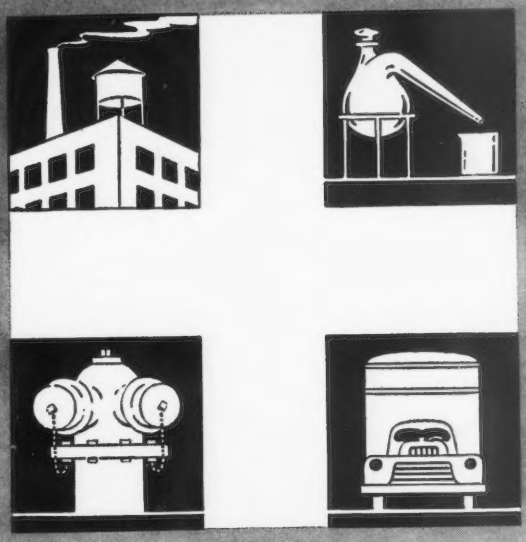

FEBRUARY, 1958

Volume III Number 1

AMERICAN SOCIETY OF SAFETY ENGINEERS

Organized 1911 — Chartered 1915

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EACH time a new chapter is chartered, the American Society of Safety Engineers passes another milestone toward its constantly expanding goals of human service and the professional advancement of safety engineering . . . Such a milestone was passed again just this last month when the Great Plains Chapter, with headquarters in Omaha, Nebraska, became the first chapter to be admitted into the Society's "family" in 1958 . . . The addition of well organized, enthusiastic new groups of professional safety engineers to chapter status has become a very pleasant habit for the Society. Three chapters were admitted in late 1957 and just a year earlier three other new chapters were placed on the Society's rolls . . . This strong, steady growth indicates, as perhaps nothing else could, the basic need for the Society in the safety movement and the highly satisfactory manner in which the Society consistently has answered this need . . . That is why we are particularly proud to list on the inside back cover of this issue, the 68 chapters of the American Society of Safety Engineers.—Editor

Our President Speaks on SAFETY

THE AMERICAN people were startled, to put it mildly, by the U.S.S.R.'s successful launchings of Sputniks I and II. Following closely was the United States' failure in its satellite-launching attempt on December 6 at Cape Canaveral, Florida.

Fortunately, public reaction to these unhappy incidents seems, on the whole, to be constructive, for apparently the bad news of late 1957 has touched off a 1958 drive, unprecedented in its determination, to further the educational program of the nation, particularly in the areas of the exact sciences.

It is almost impossible to comprehend all that this drive may mean, ultimately, to our country—and to the world—in terms of scientific advancement. Already modern discoveries have been revolutionizing our world, technologically speaking, with somewhat bewildering rapidity. In just the last two years, it seems, we have gone from the machine age through the age of electronics, the atomic age, the nuclear age—and now we find ourselves more or less hurled into the space age.

With a concentrated drive underway to create more opportunities for learning through scholarships and other assistance programs, to broaden curriculums, improve already-successful teaching methods, attract additional qualified and able faculty and emphasize the importance of every phase of education, we most surely will achieve results bearing all the appearances of miracles.

Most surely the next decade will see developments—as yet unthought of—which will completely change our mode of travel and many or all of our manufacturing processes. These changes cannot help but create a need for corresponding changes in the arts and sciences of safety engineering.

To go even further, the field of occupational safety is being presented with a new, a limitless challenge. Our world has entered an era of scientific advancement which in a few years may dwarf all the present accumulated knowledge of man. We cannot be content, as safety engineers, merely to keep pace with changing methods. To fulfill our professional responsibility we must, in the development of safety engineering technology, match industrial progress with progress in the saving of life, limb and property to the final and certainly as yet unrealized goal, virtual elimination of accidents.

We have a truly magnificent challenge—and opportunity—before us in the safety field. How well we meet the challenge, how fully we take advantage of the opportunity, will depend on the contributions each one of us is able and willing to make: how thoroughly we prepare ourselves, through study and research, to do our jobs; how enthusiastically we devote ourselves, in our professional and community lives, to the practical realization of our ideals.

John F. Juli, President
American Society of Safety Engineers

Standardization in the Field of Nuclear Energy

by Morehead Patterson

I AM SURE you all remember the story of Horatius at the bridge—three Romans successfully defending a narrow defile against a large army. It seems to me that the 7000 members of the American Society of Safety Engineers are like the three Romans—that all the best brains in the country are trying to make the world unsafe against the best efforts of the Society to keep things safe. This situation is not new; it has been going on for a long time.

In the early days of railway transportation there were those who claimed that trains could not be operated faster than 15 miles per hour because the lungs of the passengers would blow up.

The age of aviation brought us untold dangers which have been met with reasonable safety.

There is no denying the fact that there is something in atomic energy which is lethal and that we must take precautions. Nevertheless, people live through dangers all the time and for my money I would rather live near an atomic plant than in Simsbury, Connecticut, where they make explosives. Actually the safety record in atomic plants is very good. At present we have the controversy regarding the relative safety of the English gas cooled reactor and the U. S. water or heavy water cooled reactor. Each claims the other is dangerous. Personally, I think neither is dangerous if properly handled.

Plutonium, in the hands of an irresponsible man, would be a real hazard politically. Probably Caesar would have enjoyed having some plutonium. We have to live with these things. People who live on Mt. Aetna live in constant danger of lava flows.

We must guard against public hysteria and we must have government law to provide insurance. You all remember the three airplane crashes we had in Elizabeth, New Jersey. We do not want anything similar to that in the atomic industry; it would set us back a long way. The AEC rules and regulations are very adequate and we owe our fine atomic safety record to them. Standardization will make things simpler, will cut costs and get the job done.

In the past many standards have been created to iron out difficulties which have arisen through the lack of standards, but the idea of being forehanded and trying to *prevent* trouble, rather than correct it, has been basic in all operations of the original Nuclear Planning Committee of the American Standards Association and its successor, the Nuclear Standards Board. The fact that nuclear energy is a new field and that it cuts clear across industry has been foremost in our minds. Reactor builders, construction firms, insurance companies, fabricators of all kinds of materials and fittings which are parts of nuclear energy devices, labor, public health authorities and many other activities are awaiting eagerly the creation of standards in their particular fields. Unless some national standards are established soon, each state or municipality will establish its own standards and the chaos which will result will be worse than the divorce laws of the 48 states.

There are some people who feel that it is too early

Morehead Patterson is shown above as he delivered the principal address at the Annual Meeting of the American Society of Safety Engineers, held in the Grand Ballroom of the Conrad Hilton Hotel, Chicago, October 22, 1957. The text of his speech is published on these pages.

Mr. Patterson, who is president and chairman of the board, American Machine and Foundry Company, serves as chairman of the Nuclear Standards Board, American Standards Association. Also, he was chairman of the July 29-August 1 meeting of the Nuclear Energy Technical Committee of the International Organization for Standardization, held in Geneva, Switzerland.

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to do anything about nuclear standardization now because we know so little about the effects of nuclear energy. Granted that the newness of the field prevents perfection, we nevertheless must at least analyze the problems which confront us and establish basic principles which may be refined as knowledge increases and experience dictates. It is better to go ahead with the knowledge we possess and establish something to go by, rather than to wait and do nothing until we think we know it all. That time will never come. There should be no vast changes in safety measures. We should specialize in those things peculiar to nuclear energy.

To consider the need for national standardization in this field, a general conference was held in Washington, D.C., on December 8, 1955. The conference was attended by 175 prominent people representing 120 different interested organizations. After long discussion it was unanimously agreed that there was great need to develop nuclear standards and further that the American Standards Association should "appoint a Planning Committee to study urgently the question of standardization in the field of nuclear energy in detail and report back to the conference as soon as possible."

At this point, for the benefit of those who are not familiar with the organization and procedures of the American Standards Association, I would like to describe them briefly.

The ASA is a non-profit organization supported principally by member-bodies and sustaining members. Member-bodies are organizations of national scope such as the Manufacturing Chemists Association, the National Safety Council and the Atomic Industrial Forum. They are the active voting members. The principal group of sustaining members are known as company members. They share the benefits but have no vote and are not represented on any of the ASA operating agencies.

The ASA has a Board of Directors and the usual officers for administrative purposes but the actual standardization work is under the control of the Standards Council. The Council divides its work among 14 Standards Boards of which the Nuclear Standards Board is one. (Incidentally, the first Standards Board was the Safety Standards Board organized in 1920.) A Standards Board in turn breaks up its work into projects and turns these projects over to Sectional Committees which actually do the pick-and-shovel work.

A Sectional Committee may have from 12 to 50 members chosen to represent all important organizations interested in the project. Each Sectional Committee has a sponsoring organization, selected by the parent Standards Board, whose job it is to monitor the work of the committee. The Sectional Committee actually prepares the standards and before submitting them to the parent Standards Board, through the sponsor, must assure itself that a consensus has been reached. That means that every interested organization has had a chance to study a suggested standard and that there is practically universal approval.

The Standards Board itself does not pass on the technical aspects of the standard but passes judgment only on whether or not a true concensus has been obtained. If not, it will send the suggested standard back. If satisfied, the Standards Board will approve and pass on the standard to the Standards Council for final approval as an American Standard. There are two other ways which are sometimes used to secure standards, but I will not take time to describe them because the Sectional Committee method is the normal procedure for development of safety standards.

Now to return to my story—

The ASA Nuclear Planning Committee held its first meeting on February 15, 1956. Twenty-five national organizations were represented on the committee. I won't take time to go into the details of the meetings or the formation of subcommittees, etc. Suffice it to say that on May 2, 1956, the committee submitted its report to the general conference, recommending the establishment of a Standards Board, within the framework of the American Standards Association, which would have approximately the same representation as the Planning Committee and with a scope as follows:

"The scope of the Nuclear Standards Board will be the administration and planning of national standardization work in the field of nuclear energy. The Nuclear Standards Board will be assigned primary jurisdiction over such work within its field as does not fall in the field of an existing Standards Board and secondary jurisdiction over those projects which are already assigned to a present Standards Board. This secondary jurisdiction is to be for the purpose of insuring coordination. The technical work will be placed in the hands of existing Sectional Committees and existing committees of other organizations to the maximum possible extent."

The new Nuclear Standards Board held its first meeting on September 18, 1956, and has met several times since. As finally constituted it represents 32 national organizations, ten of which are technical societies, eleven are industrial organizations and five are governmental agencies, plus the Bureau of Explosives, the Conference of State and Provincial Health Authorities, the International Association of Government Labor Officials, the National Safety Council, the AFL-CIO and the American Public Health Association.

With one exception, the work of the Board so far has been to establish projects, select sponsors and organize the Sectional Committees to implement the projects.

The projects which have been set up are as follows:

N1—Glossary of Terms in Nuclear Science and Technology

This is the one exception in the work of the Board to date to which I referred. This glossary, which had been under preparation for a number of years by the National Research Council, was the first proposed standard considered by the Nuclear Standards Board and was processed by an existing standard method which is shorter than the Sectional Committee method which I described to you. It was approved as an American Standard on June 5, 1957, with the realization that it was imperfect in some aspects but at least it would meet the urgent demand for something to go on. It was also approved with the understanding that revision would be started at once. This revision is under way.

N2—General and Administrative Standards for Nuclear Energy

Briefly, this project covers terminology, definitions, color codes, symbols, qualifications of professionals, accountability, records and reporting procedures.

The sponsor is the Atomic Industrial Forum.

A Sectional Committee has been organized and has met several times. Its main work at the present time is the revision of the glossary.

N3—Nuclear Instruments

The scope of this project covers the standards, specifications and methods of testing for instruments used in the nuclear field.

There has been a delay in determining a sponsor but recently the Institute of Radio Engineers was selected and I believe work will get under way soon.

N4—Electrical Requirements for Reactors and Nuclear Power Systems and in the Generation and Application of Nuclear Radiation

The scope of this project covers standards, specifications and methods of testing electrical equipment used in the nuclear field.

Three sponsors were selected for this project; namely, The American Institute of Electrical Engineers, the Electric Light and Power Group and the National Electrical Manufacturers Association, which by agreement is the prime sponsor. Invitations have been sent out to various organizations to designate representatives on this Sectional Committee and an organization meeting is expected soon.

N5—Chemical Engineering for the Nuclear Field

The scope of this project covers just what its name signifies.

The sponsor is the American Institute of Chemical Engineers. A Sectional Committee has been organized and has held one meeting. Subcommittees have been organized and work is under way.

N6—Reactor Safety

This project is concerned with codes and standards which have to do with the safe operation of nuclear reactors, etc.—in brief, the prevention of accidents.

The joint sponsors are the American Nuclear Society and the American Society of Mechanical Engineers, which by agreement is the prime sponsor. A Sectional Committee has been organized and has held one meeting.

N7—Radiation Protection

This project has to do with protection of personnel against the effects of radiation during any normal operation in which radiation is present.

The joint sponsors are the National Safety Council and the Atomic Industrial Forum, which by mutual agreement is the prime sponsor. A Sectional Committee has been organized and has held one meeting.

Internationally, progress has also been made. A year or so ago the International Organization for Standardization, commonly called ISO, decided to create Technical Committee No. 85 to cover standards in the field of nuclear energy. It held its initial meeting in Geneva three months ago.

The United States was assigned the secretariat and we were represented by a delegation of 15 members. There were over 70 delegates altogether, representing 17 countries and seven international organizations. I believe that many of the delegates approached the meeting with a feeling of skepticism and doubt that anything of real value could be accomplished at this time. At the conclusion of the meeting, however, I talked with the heads of several of the delegations and I am confident that any misgivings they might have had initially were dispelled by the constructive work which was done and that the delegates left with an enthusiastic feeling of accomplishment.

There were two plenary sessions of the committee as a whole but the detailed work was accomplished by three working groups which were finally designated as permanent subcommittees. The subjects assigned these working groups were:

1. Terminology, definitions, symbols and units.
2. Radiation protection.
3. Reactor safety.

Of course, being a meeting to get organized and to establish programs of work to be accomplished, no recommendations were made for any specific standards, but initial steps were taken toward:

1. Development of a tri-lingual glossary—English, French and Russian.
2. Development of a warning symbol to indicate presence of dangerous ionizing radiation.
3. Adoption of units pertaining to nuclear energy—already developed by the International Commission on Radiation Protection and the International Commission on Radiological Units.
4. Development of symbols required for drawings.
5. Development of recommendations relating to measurement of and protection against radiation.
6. Development of acceptable guides for safe design, operation and maintenance of nuclear reactors.

At present there are few people in the nuclear business who are doing well. Companies are spending large amounts of money and still are trying to operate under the profit system. The business is fascinating and would be even more exciting to the companies if they did not need a profit. My own company treasurer and my bankers think I am having too much fun already.

The profit motive must come into nuclear energy. Right now there is no real demand for atomic power in the United States. Fossil fuels are so cheap and plentiful and engineering so good that atomic power is not needed and cannot be competitive at present costs. In the future, however, the demand for electric power will go up—will probably double every ten years from now on—and when the supply of fossil fuels diminishes the prices will go up. Radiation cannot be laughed off and prevention against it is costly but the time will come when atomic power will be competitive.

In closing, you can see from the brief summaries I have given you that standardization activities in the field of nuclear energy are now organized both nationally and internationally and work is under way. I hope that some standards will soon be forthcoming. Standardization work under the consensus principle is necessarily slow and in the nuclear field is further hampered because it is a new field and there are so many unknowns. As I said earlier in my talk, we want to be forehanded in this work and prevent confusion rather than to have to standardize later to correct difficulties which arise—the history of standards so frequently in the past. We must try not to be too late with too little but also we must be careful not to be too soon with too much—which could well stifle progress in industry.

Experience in hundreds of industrial plants has demonstrated that . . .

ENERGY IN COLOR BENEFITS PLANT SAFETY AND MAINTENANCE

by Thomas R. Donoghue

MODERN industrial plants with their mechanized tempo of production represent a far cry from the small, old-fashioned factory where produced material was distributed and work collected by hand trucks. Yet with today's highly mechanized plant, management is confronted increasingly with the important problem of safety and maintenance. If demand is to be met and full time operation assured, working conditions must be safe, efficient and orderly.

In past years industry has expended millions of dollars and a great amount of time and effort in promoting the physical welfare of employes. Frequently the changes recommended as a result of these time-and-motion studies appear on the surface to be trifling. The history of modern industry abounds in examples of trifles that have turned out to be of tremendous importance.

One such tremendous "trifle" is color. At first thought, it may be hard to believe that the colors on a machine, on a wall or on a traffic lane could have a marked influence on a worker's morale or his production efficiency.

As we know, unless there is light to create visibility, nothing can be seen in absolute darkness. The quantity, quality, character and color of the light are factors which determine the degree of visibility. But light must be reflected from a surface before that surface can be seen and good visibility, therefore, depends on good light and on a good surface that will reflect this light. Paint, properly handled, can provide that surface.

Not too many years ago factories were painted with little or no regard to the coordination of illumination and color. Paint was merely thought of as a covering agent, as a "protective" for wood, steel and other surfaces. Color was of our own selection, chosen simply with regard for what we thought was appropriate. Most ceilings and side walls down to contact height were

Thomas R. Donoghue is manager of safety and plant protection for the Pittsburgh Plate Glass Co., where he has been employed in safety since 1920. A graduate civil engineer, he joined the Society in 1925 and is a member of the Western Pennsylvania Chapter. He is active in the work of the National Safety Council and many other national and local safety organizations.

painted white in order to obtain maximum light reflection. The contact area—that is, the doors, trim and wainscot—were painted in a dark color so as to camouflage dirt, grease and smudge. This color treatment often minimized the ineffectiveness of those responsible for housekeeping but it did not contribute much to a healthy or safe environment. Too, that form of plant treatment did nothing psychologically to encourage housekeeping on an individual basis.

Laboratory tests and practical experience have proved that there is energy in color which affects an individual's health, comfort, happiness and safety. The drab, bleak and inharmonious color schemes of yesteryear are being replaced by functional and attractive color patterns that are in keeping with modern advancements in machinery and methods.

The medical profession has long realized that colors can be used to stimulate or to depress: hence, the painting of hospital rooms and furniture to speed recovery of patients and also to enhance the working environment of the hospital staff.

Influences Workers

Likewise, in modern factory operations it has been shown that some colors stimulate and invigorate employes, while others can be irritating and actually cause physical discomfort. Undoubtedly at one time or another you may have heard the expression, "That color seems to 'scream' at me." Some drab color may elicit the remark, "That color gives me a feeling of nausea." One color attracts attention while the other dulls it; some colors stimulate and others create an opposite effect.

By harnessing the power of color and directing that power to achieve definite predetermined ends, color can be used to serve industry—and safety—constructively. To use color purposefully, not from the standpoint of personal taste but from the standpoint of what it can be made to achieve, it is necessary to utilize the energy of color scientifically. Extensive research to develop and standardize the industrial use of color for the desired results has been carried out by the Pittsburgh Plate Glass Company.

This research has brought about the adoption, by the company, of basic principles of approach to color selection which the company calls "color dynamics." Color dynamics is intended to be more than mere styling with paints; its purpose is to harness, in a practical way, both the various attributes of color and the interesting visual illusions that can be created with color. Color has been utilized by leading hotels to impart an atmosphere of friendliness, comfort and good cheer. In offices, rooms have been made to seem more spacious and pleasing to the eye, contributing to the health and efficiency of employes.

Standardize Use in Plants

Likewise, application of color dynamics principles by many thousands of industrial plants covering many fields all over the country, is bringing about standard use, in plant work areas, of colors which relieve eyestrain, offset nervous tension and physical fatigue, minimize time-loss hazards in absenteeism and otherwise improve the efficiency and safeguard the well being of the employe. There is growing evidence that application of the principles of this science in painting factories and workrooms has produced uniformly beneficial results.

Industry Sees Benefits

A leading producer of steel products has reported the effectiveness of its color dynamics program as follows:

1. Safety: The number of lost time accidents has been reduced by 38 per cent since the program started. Eyestrain and mental fatigue required in continuous attention to production units has been greatly reduced.

2. Morale: Improved employe morale is evidenced by reduction in absenteeism from approximately five per cent to less than two per cent since the beginning of the color program. Labor turnover has been reduced from approximately 4.5 per cent to .4 per cent.

3. Production: Machine efficiency increased from 86 per cent to 96 per cent, an increase of 10 per cent, a three year study has revealed.

Similar reports from many other industrial firms employing these color principles show that, as a result of the purposeful use of color in their plants, both management and labor benefit from (1) continuity of employment, (2) improved efficiency of operation, (3) quality of production maintained and (4) encouragement of the worker to practice good housekeeping and to have pride in his equipment and its care.

One of the more important results of industrial color has been in the field of safety. Every color and color combination in the safety color code, as developed at Pittsburgh Plate Glass using the color dynamics approach, has been selected for a definite purpose. In color coding for safety, a color combination can be used to obtain high visibility, making it easier for workers to see vehicles, machinery and equipment parts and to recognize hazards. Perhaps the simplest way to understand color dynamics—what it is and how it works—is to think of it exactly as the opposite of "camouflage," which means the use of colors on materials for the purpose of hiding, deceiving or obscuring. Safety color coding, on the other hand, should emphasize and reveal, or make things "stand out." It should attract attention.

Develop Safety Color Code

Consequently, in coding for safety, color is used to draw attention of the worker to safety appliances and equipment as well as to unsafe conditions or accident exposure. This purposeful use of color in the safety color code is as follows:

YELLOW, a high visibility color, should be used as a band to mark busy aisles and moving objects overhead, such as cranes, chain hoist blocks, loading buckets, railings and curbings. Yellow with black stripes, used as parallel bars, should be employed to designate non-moving obstructions that create hazards of striking against, stumbling over or falling into, such as low beams and pipes.

ORANGE combines the vitality and intensity of red with the high visibility of yellow to produce a color which has more attention value than any other color. Orange should indicate dangerous parts or areas, such as exposed cutting edges, rollers and gears. Interior door

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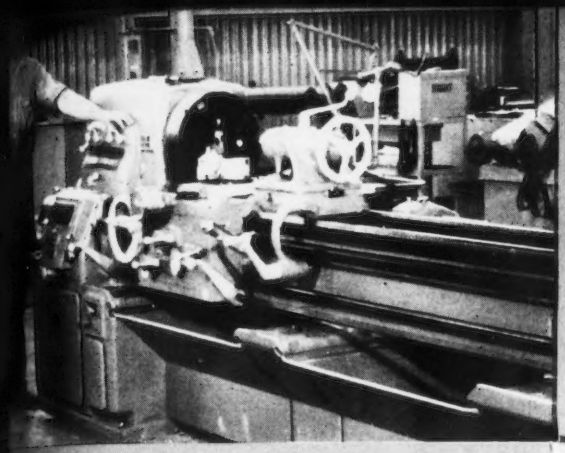

Figure 1—Use of color separates critical and non-critical parts of lathe. The body of the machine is an olive green and control levers and adjustment wheel spokes are beige (circular part of wheels is unpainted.) Tool post slide (focal area) is ivory and emergency stop and start controls are orange. All machined surfaces are unpainted.

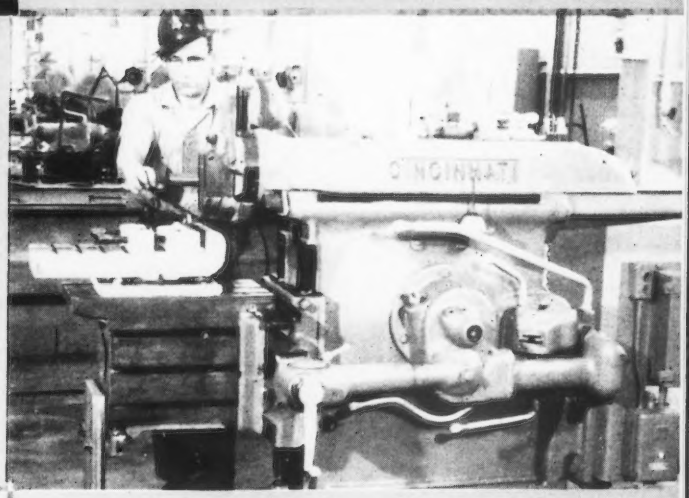

Figure 2—Shaper body is painted olive while control levers are placed in strong contrast by painting them beige. Emergency stop and start switches are painted orange, a color which combines vitality and intensity of red with visibility of yellow.

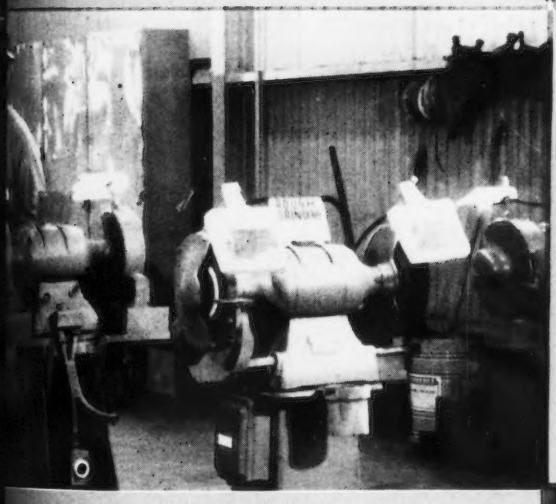

Figure 3—Beige grinder eye shields are shown in sharp contrast to olive body of machine.

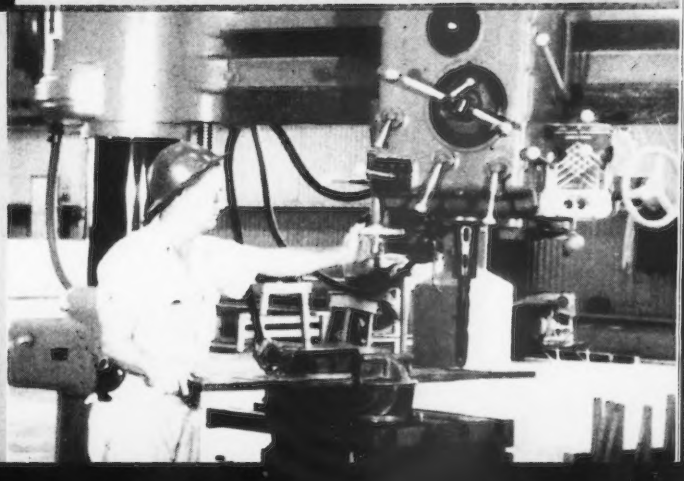

Figure 4—Large number of controls on radial drill are effectively contrasted against olive machine body by painting levers and wheel spokes beige.

surfaces of electrical switch boxes, fuse boxes, power control boxes, machinery guards and mobile equipment at floor level, such as industrial power trucks, should be painted in brilliant orange.

GREEN, always associated with safety and medical practice, should be used to identify first aid rooms, stretchers, cabinets for gas masks, respirators, medical supplies and safety showers. The green cross has come to be the standard safety designation.

RED, the physical color associated with fire, should be used to identify the location of fire fighting equipment. When marking columns where fire extinguishers are located, band the columns near the ceiling and the floor, as well as the extinguisher location.

BLUE is suggested as a caution color. Blue tags, flags or light should be employed to warn against moving equipment on which work is being done. Blue discs also can be hung on machine controls when the machine is down for repairs. Also recommended is the use, in conjunction with the tag, of safety locks on control switches when working on machines or equipment. These discs or flags should be lettered, "Out of Order." The blue flag has been used as a standard on railroads for years for protecting repair tracks and for safeguarding car loading or unloading.

PURPLE should be the basic color for designating radiation hazards. Yellow should be used in combination with purple for markers such as tags, labels, signs and floor markers. (Radiation as used in this code applies to radiation types such as X-ray, alpha, beta and gamma.)

WHITE designates traffic flow, marks off storage areas, corners and floor areas around waste receptacles.

Show Application to Machines

The illustrations which accompany this article show specific application of color dynamics and its color code to various machines commonly found in industrial plants —a lathe, shaper, grinder and radial drill. It will be noted that, although not listed as part of the code above, the colors BEIGE and OLIVE in all the illustrations, and the color IVORY in one, are mentioned as part of the color scheme in the explanations which accompany the illustrations.

Olive has been selected as the color for the non-critical expanses of the machinery because it is a quiet and pleasing color. Beige and ivory, used for some of the smaller parts of the machines which, although critical, do not fall into any of the general categories outlined in the code given above, were chosen for the dramatic but harmonious contrasts these colors provide against the olive green paint.

All machined surfaces on the illustrated machines are left unpainted.

Code Pipe Lines in Color

Color is also used to great advantage in indicating at a glance the content of a pipe line. A code for pipe line identification is as follows:

RED designates fire protection materials and equipment and sprinkler systems.

YELLOW or ORANGE identifies dangerous materials, such as acids, gases, steam at 212°F. to 800°F. and the like.

GREEN, GRAY, WHITE or BLACK marks pipes carrying safe materials, such as drinking water, compressed air and steam below 212°F.

BLUE indicates that the contents of the pipes are gases or liquids used as antidotes to dangerous materials.

PURPLE identifies pipes carrying extra valuable materials which are usually safe but of high value.

Originally, the entire piping system was painted the code color. It now is the practice to paint the piping system the same color as the ceiling or the walls and to identify the contents by painting the valves, flanges or couplings the code color appropriate for designating the material in the pipe. Some plants band the pipes when they enter or leave the wall or ceiling while others identify them with the use of colored tags or discs. The use of decals of the proper code color, lettered with the name of the material in the pipe, is preferable because this method leaves no doubt in anyone's mind as to what the pipe contains. Color coding serves as a caution signal to workmen and helps them to identify positively the pipe line on which they wish to work.

Can Bring Many Improvements

A number of safety authorities maintain that the largest percentage of injuries occurring in industry today is the result of human failure. It has been found that, when the attitude of workmen toward their work is improved by better housekeeping (which will be encouraged by a more attractive and more vividly highlighted environment achieved through the intelligent use of color), a material reduction in accidents usually results.

By means of health promotion and vision screening programs, attempts are made to conserve and improve the visual acuity of employes. Although they may have excellent eyesight, if the working environment is dull and drab and not conducive to seeing clearly and sharply, the employes' surroundings will not be conducive to safe, efficient production.

The methods and the means for creating the desired visual conditions in plants are available today although they have been used only to a limited extent. The expanded use of color dynamics can provide safety benefits that will pay dividends to management and employe alike through a reduction in accident and injuries.

Use Proves Value to Industry

The use of these color principles in industry has proved that there is much more to color than superficially meets the eye. Engineered color is producing definite worthwhile results in thousands of plants. Its success is due largely to the care and thought that has gone into the planning of the color application.

Admittedly, a few buckets of varied color paints applied in a plant is not the overall solution to industry's problems. On the other hand, carefully chosen colors, scientifically utilized, can do a tremendous job in helping to eliminate the increasingly important problem of safety and maintenance in the highly mechanized industrial plant of today.

Are Disabling Injury Frequency Rates Valid and Reliable Measures?

by John V. Grimaldi, Ph. D.

Editor's Note: *The May, 1957, issue of the Journal contained an article by Charles V. Culbertson, "Does the American Standard Method of Computing Frequency Rates Hide the Truth?" (page 18). This article was adapted and condensed from a previously-published article by the author ("Does This Standard Hide the Truth?" Magazine of Standards, January, 1957). Readers were asked to comment. So many letters were received that the Journal requested Dr. Grimaldi to write the following article, taking into account the various viewpoints expressed by readers, in an attempt to present a definitive approach to this controversial subject.*

IN THE construction of a satisfactory measure, there are two important criteria to be met. One is *validity* or, in other words, does it evaluate what is purports to? The other is *reliability*, which requires that the measure produce similar results for identical situations when it is applied by any appraiser experienced with its technique.

Recently, the Journal adapted an article by a Society member, Charles V. Culbertson (see Journal of the American Society of Safety Engineers, May, 1957, p. 18) which originally appeared in the January, 1957, issue of the Magazine of Standards, published by the American Standards Association, under the title "Does This Standard Hide the Truth?" It challenged the accuracy of frequency rates as a measure of work injury experience. The author centered his question on the sensitive part of the American Standard Method of Recording and Measuring Work Injury Experience, Z16.1-1954, which defines *temporary total disability* and excepts those cases where the injured person can be assigned to a "regularly established job which is open and available to him." Culbertson argued that:

> "The disabling injury frequency rate *should* measure the *total number of disabling injuries experienced*, not merely the ones that management could not accommodate with another job. The present definition has enabled a large plant with a variety of jobs to experience an injury and return the man to a job while the small plant across the street, suffering the same injury, must tally it as a disabling injury."

There is a certain truth to the point made, although perhaps it would have been more proper to word the last sentence less positively. It must be recognized that the small plant also may be able to find a job for the injured worker, although it is probable there would be fewer openings to choose from.

The Z16.1 provision for deleting from the disabling injury accident total those cases which do not result in permanent impairment but can perform a regularly established job, has been controversial for some time. Any measure which allows discretion and circumstances to influence its use and results, will be questioned. The Z16.1 definition of *temporary total disability* introduces such a defect.

Many accident prevention professionals in industry have been dissatisfied with this provision because it is suspected that the interest of some colleagues is centered on working to find proper jobs for qualified injured employes and, thus, advantageously influence their frequency rates. The objective of reducing the rates by focusing effort on prevention of the accident is de-emphasized by this interest, it is alleged.

It might be worthwhile to examine, carefully, first the possibility that low frequency rates may be a function of a plant's ability to reduce its *temporary total disability* cases by returning a number to available jobs. Using 1952 United States Department of Labor injury-frequency rates for manufacturing industries by size of unit, which were the most recent available when this was written, a picture of how the small plant frequency rates compare with large plants appears in the table on page 10.

It is seen that the larger manufacturing groups truly

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SIZE OF UNIT	DISABLING INJURY FREQUENCY RATE	SIZE OF UNIT	DISABLING INJURY FREQUENCY RATE
Less than 20 employes:		250 to 449 employes:	
(a) No. of units included: 63		(a) No. of units included: 131	
(b) Range:	2.2 — 93.7	(b) Range:	2.4 — 100.9
(c) Mean:	18.5	(c) Mean:	17.4
(d) Median:*	18.5	(d) Median:	17.4
20 to 49 employes:		500 to 999 employes:	
(a) No. of units included: 104		(a) No. of units included: 116	
(b) Range:	4.9 — 97.1	(b) Range:	3.3 — 80.6
(c) Mean:	20.1	(c) Mean:	13.7
(d) Median:	19.8	(d) Median:	13.6
50 to 99 employes:		1000 to 2499 employes:	
(a) No. of units included: 120		(a) No. of units included: 90	
(b) Range:	4.3 — 102.0	(b) Range:	0.9 — 40.6
(c) Mean:	22.4	(c) Mean:	9.8
(d) Median:	22.2	(d) Median:	9.6
100 to 249 employes:		2500 or more employes:	
(a) No. of units included: 146		(a) No. of units included: 45	
(b) Range:	4.2 — 108.7	(b) Range:	2.2 — 18.4
(c) Mean:	21.5	(c) Mean:	6.6
(d) Median:	21.7	(d) Median:	6.6

*** The "mean" and the "median" are both measures of central tendency but the mean, or arithmetic average, gives no quantitative indication of the rates, which are above or below the particular average referred to. In other words, the mean is not a measure of position. Where data are obtained from a sample which is representative of the normal population for the group investigated, the mean and the median will have similar values. But in practice it is often difficult to obtain a sample that is representative of the normal population for the group. The data may be more numerous at one end of the series than would occur normally. The mean, therefore, may not be indicative of a normal group.**

By contrast, the median is a measure of position in that it unequivocally indicates that 50 per cent of the numbers in the series lie immediately above and 50 per cent lie below the particular median value. It is least distorted when a series contains extreme values. The median, unlike the mean, therefore, is more typical of a particular series because of its independence of unusual values. When the mean and median are equivalent, it is some indication that the figure is an accountable measure of the central tendency of the series.

have the best frequency rates and that the most outstanding rates occur for companies employing 2500 or more workers. This is evident in the range, which is narrow, as well as in the relative lowness of the upper figure (18.4). Progressing to the groups having smaller numbers of employes, it will be noticed that the range tends to widen and the frequency rates rise consistently until the groups of less than 50 employes are reached. Then the trend reverses. Not too much, it is true, but some significance may be attached to the interruption.

Since the possibility has been admitted that the small plant is less likely to find a regularly established job for a worker who has not been permanently injured, why then do the smallest plants in this study have a better frequency rate than the plants with 50 to 249 employes? The inference that the small plant is in a less advantageous position than the larger plant when the time comes to compute frequency rates would be weakened somewhat — it seems — by this comparison.

Although in theory the small plant may be at a great disadvantage in the development of favorable frequency rates, compared with large plants, because of the Z16.1 provision in question, there are many practical considerations which have a bearing on the comparative differences. These would tend to limit this criticism of the *temporary total disability* definition.

Some of the factors to be considered are indicated by the better frequency rates for plants under 50 employes compared with those of 50 to 249 employes. It is likely that the smaller the plant, the closer is the contact between the manager and employes. It is well known that interested and close supervision is necessary in order to maintain safe operations. Since the small plant's manager is closer to the production operations, he is apt to be more observant of safety infractions, realizing more acutely the loss when accidents occur.

In the case of the medium size firms, the manager will have more subordinates at levels between himself and his employes. Although this is a situation which would prevail, also, in the larger plants, some probable differences may be present. The larger company, for example, generally has the capacity for selecting and training supervisors so that it will obtain an optimum performance from them. Also, it can afford to employ a safety engineer. It is probable, too, that the larger firms, generally, receive more intensive assistance from their workmen's compensation insurance carriers and also are encouraged to become members of safety organizations. And it is likely that because of their prominence, they receive greater attention from the state factory inspection agencies.

Obviously, therefore, there are many factors which must be working in favor of the larger company. There is probably one other consideration, however, which explains the greatly superior frequency rates of the very

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large plants. Generally, they have well-rounded medical programs which provide for prompt treatment of injuries as well as the proper selection and placement of workers. It is this facility which doubtlessly increases the ability of the larger plants to control the severity of injuries and handle favorably the cases which in other circumstances might count as *temporary total disabilities*. This may appear to be an inequity to the critics of Z16.1 since the company that is not fortunately equipped with medical assistance may expect to find its frequency rates to be comparatively poor. On the other hand, there can be no question about the merit of providing prompt and skillful medical aid after an accident occurs. This certainly must be considered to be an important, desirable step in the control of injury-severity. It might be argued just as strongly, therefore, that the present American Standard creates an incentive for employers to provide swift and capable treatment of accidental injuries. The disabling injury rates, otherwise, may be adversely affected.

Casts Doubt on Reliability

The strongest and most interesting evidence which arouses suspicions of the reliability of the disabling injury frequency rate is the relationship Culbertson plots between frequency and severity rates and the average days charged per injury. He shows figures, using the National Safety Council's Accident Facts, which demonstrate that a general reduction is taking place in frequency and severity rates from 1945 to 1955, while a progressive increase in the average days charged per injury occurs for the same period. Culbertson uses this information to make the point that "one of the basic obligations of the safety engineer—to eliminate the serious hazards first" appears to be contradicted by the increasing average days charged per injury. Whether this increase can be attributed to a failure to give primary attention to controlling the more severe hazards is a debatable conclusion. The figures, however, indicate incontrovertibly that something is remiss.

Examination of the frequency and severity rate trends for the 1945 to 1955 period discloses that the frequency rate has decreased more rapidly than the severity. This is the arithmetic reason, of course, for the increase in the average days charged per injury. However, the fact that the severity rate has been dropping consistently, if not to the same degree as the frequency rate, indicates that effective work is being done in the control of severe hazards. It is not correct to make the fairly common assumption—which was not expressed or implied by Culbertson—that concentration on reduction of the frequency of accident occurrences will automatically reduce the severity rate.

Need Better Measure

The nub of the problem, it appears, is the unreliability of the frequency rate as an indicator of performance. Theorizing on the reasons for the variance that has been discussed can do no more than support the need for a more accurate measure and perhaps point out the weaknesses to be overcome by any successor measure.

It is possible, for example, that the frequency rate is dropping more rapidly than the severity because the allowances of the controversial Section 1.2.4 of Z16.1 now are more generally applicable. It may be, for example, that there is an increasingly greater control of the cases which once would have resulted in one or several days lost time, because of a wider availability of industrial medical service. In this instance, the lower frequency rates might be explained as being more attributable to improved injury control than they would be to advanced safety techniques. Nevertheless, whatever the valid reasons responsible for the reduction of the frequency rate, the result is worthwhile if the principal reason is that, one way or another within the requirements of Section 1.2.4, more injured workers are being returned promptly to a job. This subject is a topic for criticism and discussion, therefore, only so far as it affects the frequency rate as a measure. There can be no question of the desirability of encouraging the speedy return of injured workers to a job whenever possible.

The abstracted version in the Journal of Culbertson's article, which originally appeared in the Magazine of Standards, does not make it clear that Culbertson agrees with this principle. However, his remarks in the lengthier piece indicate this agreement.

The disagreement with Z16.1 would seem to be centered basically, therefore, on whether the frequency rate, as a measure of work injury experience, is valid and reliable. Under the circumstances, there appears to be evidence that the rate can be challenged on these grounds.

To solve the problem as Culbertson describes it, he proposes: "A simple answer would be to change the definition to read, '. . . which renders the injured person unable to perform *his regular job.*'"

Unfortunately, the answer is not that simple. The proposal may reduce the probable advantage of the larger plant, with its many jobs, over the smaller plant when it comes to locating an injured employe at a regularly established job. An attempt has been made to describe here, however, how this would not solve the inherent weaknesses in Z16.1, which so many safety engineers sense and which contribute to its faulty reliability and validity as a measure.

Critical Reviews Helpful

Under the circumstances, Z16.1 is the best available and must be used for national compilations of work injury experience until a better measure can be prepared. Culbertson's valuable and interesting article should be one of many probing observations on Z16.1 extended by members of the safety engineering profession in an attempt to define the problem so that a more accurate measure will be available some day. In moving in this direction, it would be worthwhile to keep the thought that Frank Gilbreth offered some time ago: "A good observer sees what he is not looking for, if it is there; and *does not see what he is looking for, if it is not there.*" (The italics are not his, but this writer's.)

There is so much personal feeling about Z16.1 that it may not be easy to avoid the scientific pitfall that is ahead of anyone setting out to prove a belief, rather than testing it. Z16.1 is an important element of the safety engineer's present professional equipment. It deserves the best of his attention but the consideration given it should be as clinical, objective, analytical and comprehensive as possible.

Safety rule on tying of ladders can be enforced more easily if workers are provided with this

LADDER safety device

by Charles S. Wolff

PRIMITIVE man used ladders. In the highly developed civilizations of Egypt and Rome, ladders were commonplace and they have remained so down through the ages. This may be at least a partial explanation for today's all too widely held assumption that people know how to climb and work from ladders safely.

Statistics show that such an assumption is incorrect. According to the 1953 edition of Accident Facts, industrial ladder accidents cause about 40,000 disabling injuries per year, nationally. This figure is based on a projection of reports from the labor departments of nine states. In these states in 1952, ladder accidents made up from 1.7 per cent to 2.5 per cent of all industrial accidents, with the average being 1.9 per cent.

A study of 140 ladder accident cases made by the National Safety Council shows that in fully one-third of the cases the ladder concerned was not securely fastened.

Securing of ladders, it would seem, is more than a minor problem for many safety departments. One industrial organization, the Dunlop Tire and Rubber Corporation of Buffalo, New York, has met this problem with a combination of comprehensive safety rules and a unique ladder safety device which, in use for some years, has been well accepted by employes.

To illustrate the possible value of this device, let's suppose that, in some unnamed plant, you are given, as foreman of an electrical gang, the assignment of pulling a wire through 100 feet of conduit which extends over a long row of machinery. The work area is high and crisscrossed by steam pipes, hot water pipes, electrical conduits and a truss which is part of the structure.

Two electricians are dispatched to the job. At the designated place in a department the men pick up a 20 foot straight ladder after unlocking it and removing the chains.

(Since this particular plant is imaginary, let's also suppose that ladders are kept in a special place and are locked up to prevent unauthorized use. In selecting the place where ladders are to be stored many items have to be considered, including such factors as ease of handling, prevention of warping and deterioration due to heat, moisture and fumes.)

Arriving at the work area, the men place the ladder against a steam pipe. Since the ladder appears to be steady the first electrician goes up and begins feeding the fish tape into the conduit. A sudden jerky movement causes the ladder to skid on the metal deck floor. Grabbing the nearest support, the electrician is able to prevent the ladder from falling. However, in doing so he suffers minor burns from a hot steam pipe. In this case severe injury is averted and a quick inspection of the ladder shows that one of the pads on the metal safety shoes has been dislodged.

This accident could not have happened if the ladder had been tied at the top before the work began. The tying procedure, part of general ladder safety rules, is hard to enforce unless the employe is provided with an easy, fool-proof method for securing the ladder.

The Plant Engineering Department of the Dunlop Corporation some years ago developed a safety device which seems to fill this need for a quick, convenient and positive method for securing any type of ladder to the support on which the ladder rests. The device also can be used to fasten the ladder at the bottom or intermediate points depending on the location of available support. (The unit was developed for use within the Dunlop plant and is not made for commercial distribution.)

The device is used in the following way: when it becomes necessary for an employe to work at the top of a ladder he first places the ladder against the support. He then climbs the ladder, moving the slide along the ladder rail to the rigid pipe, beam or truss to be used as support. He places the cable around the support and snaps it back on itself, thus securing the ladder to the support. Greater tension on the cable tightens the grip of the slide on the ladder rail. Both ladder rails can be equipped with the device, enabling the workman to effect positive support at almost any point on either or both sides of the ladder.

The accompanying drawings (pages 11 and 15) and pictures show how the unit operates. A bolt is placed at the top end of both ladder rails so that the safety device cannot slide off.

The casting, which forms the main part of the unit, is made of malleable iron. These castings are made for Dunlop by an outside foundry. The ladder safety devices are carried as a stock item and all new ladders are provided with the locking device.

Safety engineers at Dunlop know that the ladder safety device is at best only a partial answer to the problem. Another valuable tool in their work on control of ladder accidents is a complete set of ladder safety rules. These rules, which are constantly emphasized in the plant's

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safety program, are distributed to employes in mimeographed form and often are discussed as the principal topic at safety meetings.

The rules read as follows *(those which refer to the ladder safety device are printed in italics)*:

Rules and Regulations Governing the Use of Portable Ladders

These safety rules and regulations shall apply to all portable ladders.

PURCHASE

1. The following types of ladders will be considered as standard types for general use in the company:
   a. Straight ladders—12, 16 and 20 ft.
   b. Extension ladders—30 and 40 ft.
   c. 6 ft. stepladder.
   d. 12 ft. platform stepladder.

   These ladders will be procured by the purchasing department as required by the various operating departments. The purchasing department shall specify on the purchase order that these ladders must meet the construction requirements of the American Standards Association, Safety Code for the Construction, Care and Use of Ladders, A-14.
2. Other portable ladders for specific purposes shall be purchased only on requisition through the Safety Department.

STORAGE

1. Ladders shall be stored so as to provide ease of access or inspection and to prevent accidents when withdrawing a ladder for use.
2. Satisfactory methods of storing straight ladders and extension ladders are:
   a. Hanging horizontally on wall brackets.
   b. Supported on edge in racks.

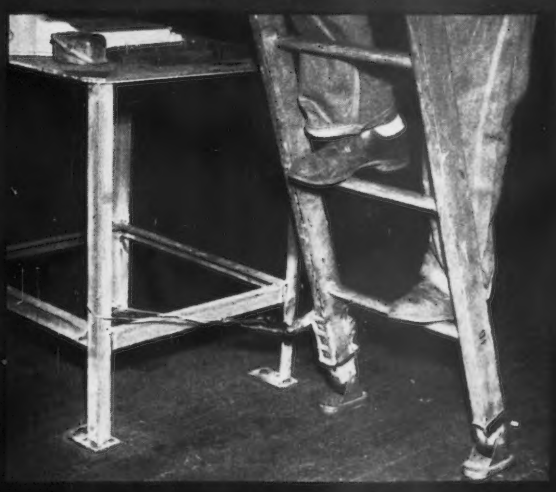
   There must be at least three points of support for all ladders over 12 ft. in length to prevent warping.
3. Ladders must not be stored near radiators, stoves, steam pipes, outside or in other places subjected to excessive heat or dampness.
4. Ladders must be stenciled with the department number or name and the date they are put into service. Also, each ladder is to be provided with a serial number attached to the inside of the rail.

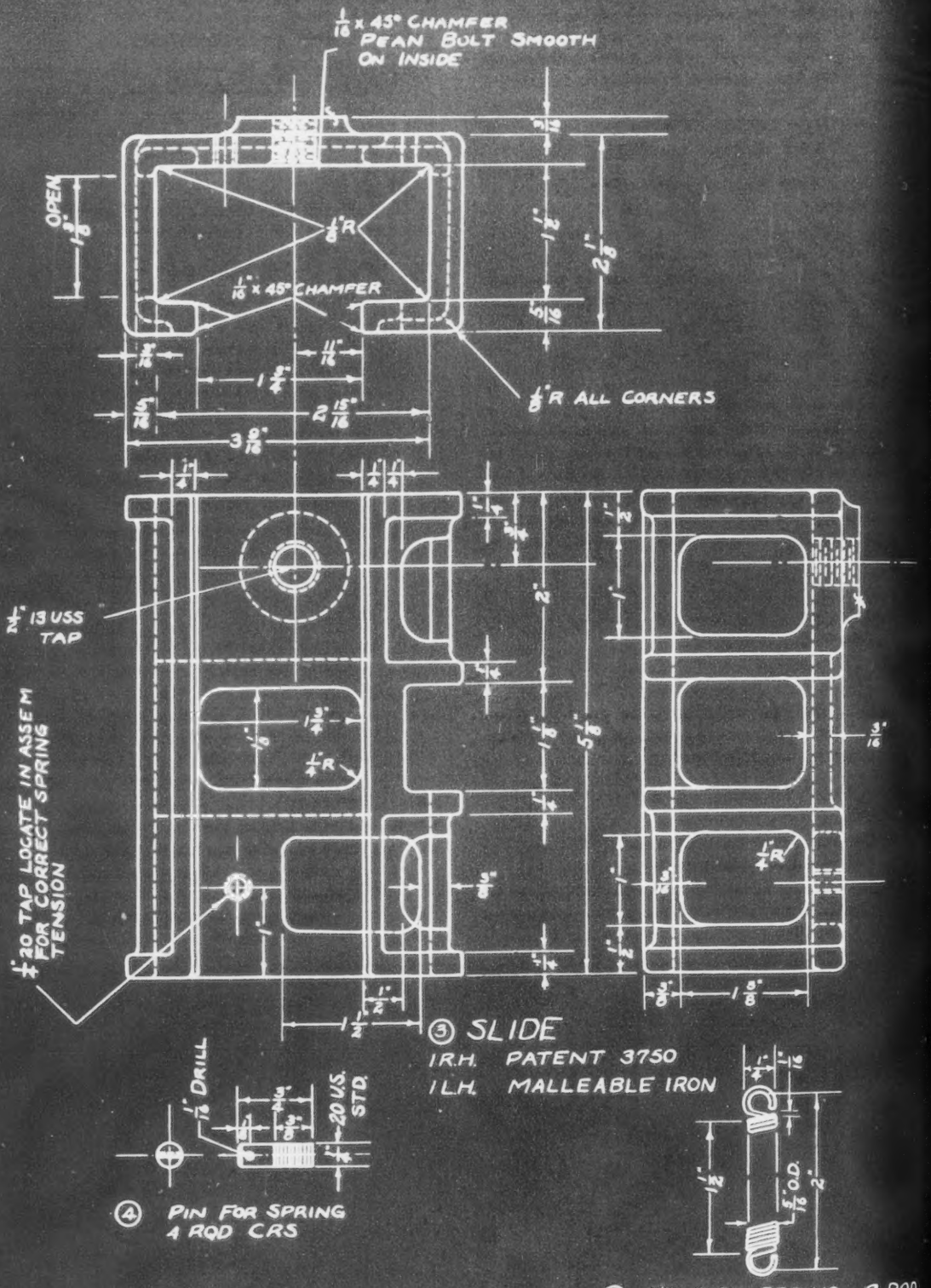
USE

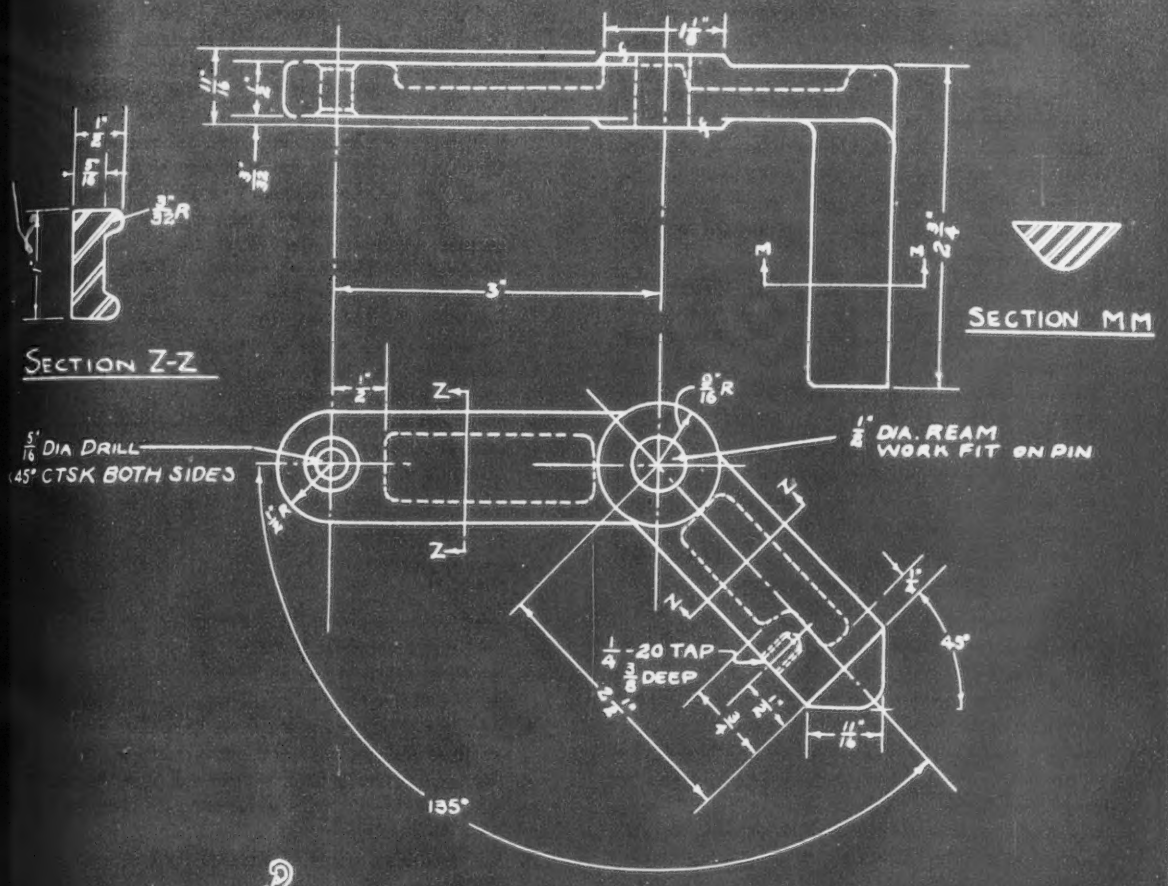
The following regulations and safe practices are to be observed in the use of portable ladders:

General

1. Do not use an unsafe or makeshift ladder—get a safe one. A safe ladder is not wobbly, has tight rungs and side rails and is free from splinters, serious cracks and breaks. The hardware is sound and in good working condition. Rope is sound and of right size. Safety feet are of suitable design for the intended use of the ladder. In any case when an employe is doubtful as to the safety of the ladder, he is to get in touch with his foreman or his department's office for advice.
2. Wood ladders must be handled and used with care to avoid damaging them. Avoid dropping ladders. If a ladder is dropped, it must be inspected at once for any change that may have resulted from the fall.
3. In taking a ladder off a hanger or rack, or in replacing the ladder on a hanger or rack, handle it so as to prevent dropping it or abusing it. When carrying a ladder keep it clear of the ground so that the ends do not drag. Keep the front end high enough to clear a man's head, if possible. Two men are required to carry any ladder longer than 12 ft.
4. Portable ladders shall be so placed that the side rails have a secure footing and firm base. The top ends of straight and extension ladders must be placed against supports reasonably rigid and strong enough to support the load.

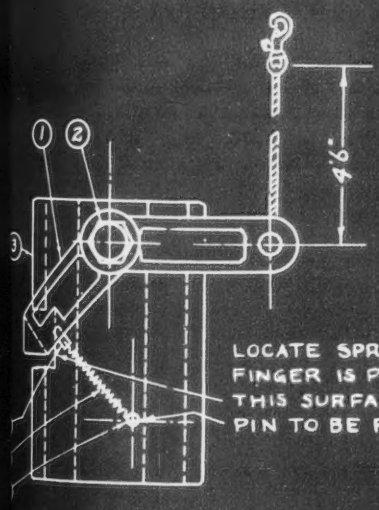



1/16 x 45° CHAMFER PEAN BOLT SMOOTH ON INSIDE
OPEN
1 3/8"
1/8"R
1/16" x 45° CHAMFER
1/8"R ALL CORNERS
1/4"-13 USS TAP
#20 TAP LOCATE IN ASSEM FOR CORRECT SPRING TENSION
1/4"R
③ SLIDE
I.R.H. PATENT 3750
I.L.H. MALLEABLE IRON
1/16" DRILL
20 U.S. STD.
④ PIN FOR SPRING 4 ROD CRS
.5" O.D.
⑤ TENSION SPRING 2 ROD #17 GAGE (054) SPRING WI



FINGER

① 1-R.H. PAT. # 3748
⑥ 1-L.H. PAT. # 3749
MALLEABLE IRON



SSEMBLY OF SAFETY DEVICE
R.H. SHOWN

NO	PART		NO. RQ.
1	FINGER R.H.	SEE DETAIL	1
2	HEX HEAD CAPSCREW	1/2"-13 x 1 1/4" LG.	2
3	SLIDE	SEE DETAIL	1 R.H. 1 L.H.
4	PIN	1/4" DIA x 1/2" LG	4
5	TENSION SPRING	SEE DETAIL	2
6	FINGER LH	OPPOSITE SHWN.	1

SAFETY DEVICE FOR LADDERS	
COMPANY DUNLOP TIRE AND RUBBER CORP.	
APPROVED	
SCALE NOT TO SCALE	DATE

5. Whenever it is necessary to place a ladder in front of a door opening toward the ladder, block the door open, lock it or have someone guard it.
6. Ladders placed where there is considerable traffic of shop vehicles or pedestrians are to be guarded by an attendant or the space should be roped off or otherwise barricaded.
7. Ladders shall not be placed on boxes, barrels or other unstable bases to obtain additional height. If more height is needed, get a longer ladder.
8. Never splice short ladders together to provide longer sections.
9. Ladders may not be removed from one department for use in another department without first notifying and obtaining the consent of the department foreman.
10. Do not reach out from a ladder more than arm's length.
11. Face the ladder and use both hands when climbing up or down. If material or tools have to be raised or lowered, use a rope, or container and rope, or carry securely in pockets or belt.
12. Ladders must not be used as a guy, brace, skid or for other than their intended purpose.

Straight and Extension Ladders

1. *Straight ladders must be equipped with ladder shoes and with cable clamp before being placed in service.* Extension ladders are to be equipped according to the use required of them.
2. Straight ladders and extension ladders should not be used for any job that requires the continuous use of both hands.
3. *The ladder must be placed so as to prevent slipping and a cable is to be attached at the top before working from ladder.*

Stepladders

1. Stepladders shall be used only as stepladders and not as straight ladders.
2. Always spread a stepladder correctly so that it is steady and safe. Whenever possible, place the stepladder at a right angle to the work; that is, with either the front or back of the ladder facing the work.
3. Remember, the top is intended as a shelf and men are not allowed to stand on it.

Remember:

See that your ladder is in a safe condition—be sure the footing is secure or lash the ladder or have someone hold it—see that the top has a firm safe rest—climb carefully.

The foremen shall have the responsibility of seeing that these rules and regulations are understood and observed by the workers under their supervision.

INSPECTION AND TESTING

1. New portable ladders shall be inspected upon receipt by the carpenter shop to determine compliance with the American Standards Association specifications.
2. Ladders used exclusively by one department shall be inspected and tested monthly by the foreman or his designated assistant in accordance with the procedure described below.
3. Instructions for Inspection—A thorough inspection should be made in a careful manner. Determine the depth and seriousness of any breaks or cracks. If you have any doubts as to the ladder's being safe, do not use it. Instead, tag it for repair, turn it in to the carpenter shop and get another ladder. Closely observe any small cracks or other defects when you test the ladder. You may find that what seemed to be a small crack or break is really a serious defect and the ladder is not safe for use. Inspect the hardware carefully. Look for loose nails, screws, bolts and other loose metal parts. Examine the rope on extension ladders for defects. Look for loose steps or rungs, damaged or worn safety feet and splinters. If splinters are bad, turn the ladder in for repair.
4. Any ladders found to be defective through inspection or testing must be tagged immediately with the standard 5 x 8 inch red tag, "Dangerous—Do Not Use," and must be turned over to the carpenter shop for repair.

MAINTENANCE

1. The carpenter shop is responsible for the repair and maintenance of ladders.
2. Ladders that cannot be repaired satisfactorily are to be destroyed.
3. Ladders shall be given a coat of shellac or varnish at least once a year and more often if necessary.
4. Rungs and steps must be cleaned of oil or grease and roughened with sandpaper if necessary to prevent slipping.
5. Ladders must never be painted because paint hides defects.
6. Repairs to ladders should be only those of a minor nature and should be made under the advice and direction of the carpenter shop foreman. If any doubt exists as to the safety of any ladder this department will destroy the ladder.

LADDERS FOR SPECIAL PURPOSES

1. The Safety Department shall be consulted regarding the design of ladders for special purposes. Ladders must not be altered unless permission is obtained from the supervisor of the using department.

ACKNOWLEDGMENT

This article is based on information and a blueprint of the ladder safety device which were supplied to the Journal by Nicholas R. Hunter, safety engineer for the Dunlop Tire and Rubber Corporation, Buffalo, New York, and a member of the Niagara Frontier Chapter, American Society of Safety Engineers. The author gratefully acknowledges Mr. Hunter's assistance.

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